केवल कार्यालयीन उपयोग हेतु
For official use only

भारत सरकार – Government of India

रेल मंत्रालय – Ministry of Railways

ब्लास्टिंग

BLASTING



केमटेक/2016/सि/ब्लास्टिंग/1.0

CAMTECH/2016/C/BLASTING/1.0

अअभासंRDSO
रेल अग्रदूत Transforming Railways
www.rdso.gov.in

An ISO 9001:2000 Certified Organisation
उच्च अनुरक्षण प्रौद्योगिकी केंद्र
Excellence In Maintenance

Indian Railways

Centre for Advanced Maintenance Technology

महाराजपुर, ग्वालियर - 474005

Maharajpur, Gwalior – 474005

✆ : 0751 - 2470869 & Fax : 0751 – 2470841

E_mail : dircivilcamtech@gmail.com

ब्लास्टिंग

BLASTING

प्राक्कथन

ब्लास्टिंग एक ऐसी क्रिया है, जिसमे कर्मचारियों एवं आसपास के लोगों के साथ दुर्घटना एवं हानि होने की संभावना बनी रहती है।

यह अति आवश्यक है कि ब्लास्टिंग की विभिन्न गतिविधियों में संलग्न लोगों को सुरक्षा सावधानियों से अवगत कराया जाये।

कैमटेक के सिविल अभियांत्रिकी विभाग द्वारा यह पुस्तक "ब्लास्टिंग" पर तैयार की गई है जो कि निर्माण कार्य तथा अनुरक्षण कार्यों में लगे लोगों के मार्गदर्शन हेतु बनाई गई है।

यह उम्मीद है कि यह पुस्तक भारतीय रेल के व्यक्तियों को ब्लास्टिंग से संबन्धित जानकारी प्रदान करने में लाभदायक सिद्ध होगी।

कैमटेक / ग्वालियर **(ए.आर.तुपे)**
दिनांक : 11.01.2017 **कार्यकारी निदेशक**

Foreword

Blasting is a process having lot of hazard which often lead to accidents and casualty of workers and nearby people.

It is quite necessary to be aware about the safety precautions for various operations involved in blasting process.

Civil Engineering Department of CAMTECH has prepared a handbook on "Blasting" for guidance of civil engineering personals who are engaged in construction and maintenance activities.

It is expected that this handbook will be quite helpful to provide information regarding Blasting to civil engineering personnel of Indian Railways.

CAMTECH/Gwalior **(A. R. Tupe)**

Date: 11.01.2017 **Executive Director**

भूमिका

भारतीय रेल एक ऐसा बड़ा संगठन है एवं इसमें निर्माण और अनुरक्षण की विभिन्न गतिविधियों का समावेश है

इन गतिविधियों के दौरान ब्लास्टिंग का प्रयोग अधिकांशतः चट्टानों की कटिंग, कुओं की गहराई, चट्टानों में नीव की खुदाई एवं सुरंगों के निर्माण आदि कार्यों में होता है।

चूंकि ब्लास्टिंग एक खतरनाक कार्य है और इसमें हमेशा ही कर्मचारियों एवं आसपास के लोगों के साथ दुर्घटना की संभावना बनी रहती है।

इस पुस्तक को बनाने का उद्देश्य ब्लास्टिंग पद्धति एवं उसमें अपनाई जाने वाली सुरक्षा सावधानियों की जानकारी एवं ब्लास्टिंग के पूर्व, ब्लास्टिंग के दौरान एवं बाद की सुरक्षा सावधानियों की जानकारी देना है।

यह पुस्तिका वैधानिक नहीं है इसमें दी गई जानकारी का उद्देशय केवल मार्गदर्शन है इसमें दी गई जानकारी किसी न किसी रूप में संबन्धित कोड एवं कोड मैनुअल, एक्ट और सर्क्युलर और अन्य मुद्रित रूप में उपलब्ध है।

यह पुस्तिका विषय पर उपलब्ध भारतीय रेल कार्य संहिता, इंजीनीयरिंग कोड, आर.डी.एस.ओ. सर्क्युलर एवं ज़ोनल रेल्वे द्वारा जारी निर्देशों और कोड का स्थान नहीं लेती है।

इस पुस्तिका के सुधार हेतु पाठकों के किसी भी सुझाव का हम स्वागत करते हैं।

कैमटेक / ग्वालियर **(ड़ी.के.गुप्ता)**

दिनांक : 31.12.2016 **संयुक्त निदेशक/सिविल**

Preface

Indian Railway is a big organization and having various activities in the field of construction and maintenance.

During these activities, blasting is often used for cutting of rock, deepening of wells, excavation of foundation in rock and in construction of tunnels etc.

As the blasting is hazardous process, there is always a possibility of mishaps with the worker and nearby people.

This handbook is prepared with the objective to provide information about the blasting process and precautions to be adopted before, during and after blasting etc.

This handbook does not supersede any existing instructions from Railway Board, RDSO, Zonal Railways, BIS Codes, Provision of IRWM and reports on the subject.

This handbook is not statutory and contains are only for the purpose of guidance. Most of the data and information mentioned herein are available in some form or the other in the various books and other printed matter. For more in depth information, the relevant codes and manual on the subject may be referred before final implementations of any technique/method describe in this handbook.

We welcome any suggestions from our readers for further improvements.

CAMTECH/Gwalior **(D.K.Gupta)**

Date : 31.12.2016 **Joint Director/Civil**

विषय-सूची / CONTENT

कृमांक S.N.	विवरण/ Description	पृष्ठ कृमांक Page No.
	प्राक्कथन/Foreword	i
	भूमिका/Preface	ii
	विषय-सूची/ Content	iii
	संसोधन पर्ची/Correction slip	iv
1.	**परिचय** / Introduction	01
2.	**ब्लास्टिंग हेतु परिभाषाएँ**/Terminology for Blasting	01
3.	**ब्लास्टर के कर्तव्य**/Duties of Blasting Mate	04
4.	**सामग्री को एकत्र करना और परिवहन**/Collection and Transport of Material	06
5.	**ब्लास्टिंग में उपयोगी सामग्री कर परीक्षण**/Testing of Material use for Blasting	08
6.	**ब्लास्टिंग की प्रक्रिया और तरीका** / Procedure and Method of Blasting	08
7.	**यातायात निरुद्ध और पावर ब्लॉक ओर ट्रैक एवं भवनों की सुरक्षा** / Removal of Traffic and/ or Power Block and Protection of Track & Buildings	13
8.	**ब्लास्टिंग के पहले ब्लास्टिंग के दौरान एवं बाद की सावधानियाँ**/ Precaution before, during and after Blasting	13
9.	**आवृति प्रोग्रैस रिपोर्ट जमा करना**/Submission of Periodical Progress Report	14
10.	**मैगज़ीन के विस्फोटकों की सुरक्षा एवं रखने का लेखा-जोखा**/ Custody and Storage of Explosives in Magazine and their Accountal	14
11.	**विस्फोटकों का निपटारा /** Explosive Disposal	16
12.	**विस्फोटकों का निरस्तीकरण /**Destruction of Explosives	16
13.	**चेकलिस्ट**/ Check-list	18

संशोधन पर्चियों का प्रकाशन
ISSUE OF CORRECTION SLIPS

इस पुस्तिका के लिये भविष्य में प्रकाशित होने वाली संसोधन पर्चियों को निम्नानुसार संख्यांकित किया जायेगा

The correction slips to be issued in future for this hand book will be numbered as follows:

केमटेक/2016/सि/ब्लास्टिंग/1.0/सीएस/XX दिनांक
CAMTECH/2016/C/Blasting/1.0/CS/XX date

जहाँ XX संबन्धित संसोधन पर्ची की कृम संख्या है (01 से प्रारम्भ होकर आगे की ओर)
Where "XX" is the serial number of the concerned correction slip (Starting from 01 onwards.)

प्रकाशित संसोधन पर्चियाँ
CORRECTION SLIPS ISSUED

कृमांक *S.N.*	प्रकाशन की तारीख *Date of issue*	संसोधित पेज कृमांक तथा मद संख्या *Page no. and item No. modified*	टिप्पणी *Remarks*

1. परिचय / Introduction

Blasting is a specialized job involving a lot of hazards which often lead to accidents and casualty of workers and nearby peoples. Since blasting is a hazardous process, therefore it is quite necessary to be aware about the safety precautions for various operations involved in the process of blasting for the guidance of those who are engaged in the work. By awareing the persons involved in the process of blasting we can minimize the injuries and casualty of workers and nearby peoples.

Blasting is commonly required in the following cases:

a) Clearing of boulders which fall on the railway line as in ghat sections
b) Quarrying rock
c) Widening the rock cutting
d) Deepening of wells
e) Cutting in rock
f) Excavation of foundations in rock
g) Construction of tunnels
h) Dismantling of building and structures

2. ब्लास्टिंग हेतु परिभाषाएँ /Terminology for blasting

Following definitions are associated with Blasting:

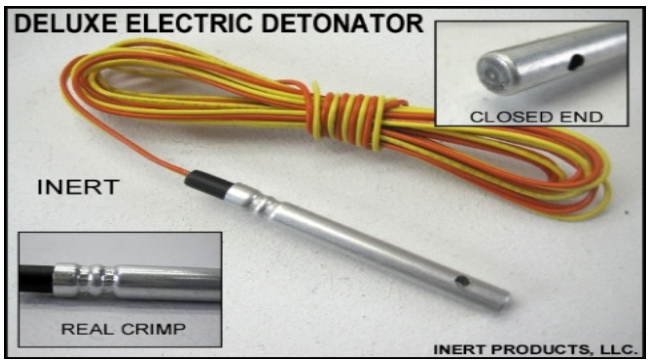
i) Blasting Mate: The person assigned the duty of loading and blasting the explosives.

ii) Detonator: Any device containing a detonating charge that is used for initiating detonation in an explosive. The term includes:-

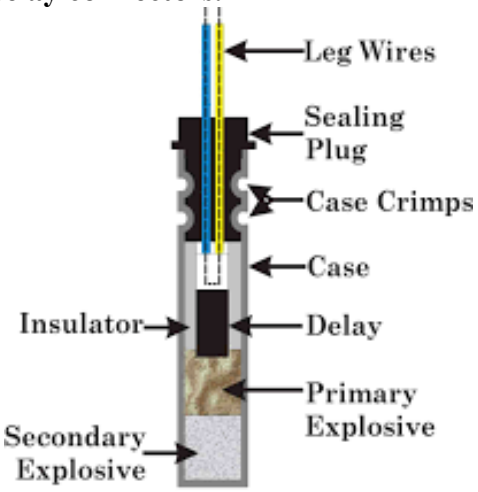
a) **Electrical blasting Cap:** A shell containing a charge of detonating compound which is ignited by an electric current from two projecting insulated leg wires.



b) Blasting Cap: A shell closed at one end and containing a charge of detonating compound, which is ignited from a spark. It is used for detonating explosives.



c) Detonating cord delay connectors.



Electric Detonator

iii) Explosives: Any mixture or chemical compound which is capable of producing an explosion by its own energy. This includes black powder, dynamite, nitroglycerine compounds, fulminate, or explosive substance having explosive power equal to or greater than black powder.



iv) Magazine: Building or structure used for the storage of explosives.



v) Missed holes: A drilled hole containing an explosive charge that failed to explode.

vi) Safety fuses/ Detonating fuses: A medium manufactured especially for firing explosive charges, that conveys a flame at uniform rate rather than one that is in itself a detonator or one that operates on some other principle.



vii) Permanent blasting wires: Wires between the firing switches, for use in blasting where the power source is an electric circuit.





viii) Stemming: Material used for confining a charge of explosives in a hole or to cover explosives in mud-capping.

ix) Stemming of sand: Process of filling the empty parts of a bore holes with an inert stemming material like sand to retain the products of the detonation of an explosive charge in enclosed space.

x) **Primer:** An explosive cartridge with a detonator or igniting agent inserted therein.



xi) **Crimpers:**





3. ब्लास्टर के कर्तव्य / Duties of blasting mate

No person shall be appointed to be a blaster unless he is the holder of blaster certificate, which is issued by Director General of Mines Safety (DGMS).

The Blasting mate shall be responsible:

a) To see that,

- When blasting is conducted in the neighborhood of a public or any place where there may be people who would be endangered.
- Experienced Watchmen should be sent with red flags to stop traffic or warn persons.
- These Watchmen must be informed from the work spot regarding the commencement and cessation of blasting operations.
- Proper communication between watch man and work spot should be there.

b) To see that, before blasting commences, all persons except those who are actually to light the fuses, are warned by the repeated striking of an empty tin or blowing of a siren and are at a distance of not less than 150 metres and that, in special cases, suitable extra precautions are taken.

c) To see that, in order to avoid damage to structures (such as girder bridges and telegraph wires) which may be in close proximity to the blasting spot, only shallow bore-holes are drilled and light charge used or vary the angle of bores to control the blast.

d) To select person as carriers of the explosives, detonators and safety fuse, and to issue suitable instructions when above said material have been drawn from the magazine by them.

e) To ensure that no one interferes in his absence with any explosive, detonators or caps already drawn by him from the magazine.

f) To see that neither he nor any person within 10 metres of him smokes while he is conveying, handling or using explosives.

g) To see that,

- Bore holes are of such a size that cartridges can easily pass down them.
- Bore holes are clear of all debris before a cartridge is inserted.
- Charging is done by him and the positions of the charged holes are noted carefully.

h) To drop several centimetres of tamping of sand or clay on top of the primer cartridge before beginning to stem or press and that this tamping is gently pressed down on top of the primer without the use of force;

Note: The primer-cartridge is the cartridge in which the detonator or cap and fuse are attached and is usually fixed as the last cartridge of the charge.

j) To see that the safety fuses of the charged holes are lighted in his presence and have properly ignited.

k) To compare the number of shots actually heard with shots intended to be fired and to carefully inspect the work after blast and satisfy himself that all holes have exploded and the broken rock does not contain any unexploded cartridge or pieces of cartridges.

l) To take precautions as given below in cases of misfires:

- if a charge has apparently missed fire, to immediately warn all present and see that no person is allowed to go near it for an hour,
- if a charge misses fire, to examine the hole and mark a red cross over it,
- to see that a shot that has missed fire is not bored or picked out; that no further charge is introduced into the hole ;
- to determine the direction of the hole for which purpose a few centimeters (inches) of tamping may, if necessary, be picked out and a stick placed in the mis-fired hole and to drill, after 60 minutes have passed, a fresh hole near the charge which has missed fire and that this is done at a safe distance from the former hole and in such position and direction that the boring tool cannot come

- in contact with the explosive which has missed fire. The Blasting Mate must not leave the spot on any account whatsoever until the second hole (which should explode the old charge) has been fired. He must carefully examine the result and continue the operation, if necessary, until the original charge has exploded.

m) To make sure that there is only one key to the exploder and that this is in his pocket when he has to leave the exploder. This is necessary for his own protection.

4. सामग्री को एकत्र करना और परिवहन /Collection and transport of material

4.1 General

AEN and SSE/JE should ensure that:

- All the relevant central, state and local laws and rules and regulations framed there under shall be complied and necessary license has been obtained.
- Loading, unloading and handling of explosives shall be supervised by qualified personnel.
- At the time of loading or unloading of explosives, no electrical switch should be operated.
- They are acquainted with the instructions contained in the I.R.C.A Red Tariff no. 16 "Rules and rates for the conveyance by rail of explosives and other dangerous goods".
- If carried by road vehicle, the vehicle should have the necessary license issued for the purpose.

4.2 Containers

- For carrying small quantity (up to 5 kg of explosives) specially designed insulated containers may be used.
- This container shall be constructed of finished wood not less than 50 mm thick or plastic not less than 6 mm thick or pressed fibre not less than 10 mm thick.
- Metal components, including nails, bolts, screws, etc, shall not be used in the construction of the containers, which shall be waterproof and provided with lids.
- The containers shall be provided with suitable non-conductive carrying device, such as rubber, leather or canvas handle or strap.

4.2.1 Each explosive container should be clearly and indelibly marked to indicate:

i. Manufacturer's name or trade mark,
ii. Name of the explosive,
iii. Lot number,
iv. Date of manufacture,
v. Expiry date, and
vi. The words 'EXPLOSIVE", HANDLE WITH CARE

4.2.2 Containers used for storing explosives or detonators shall be used for that item only.

4.3.1 Vehicles

The vehicles used for transportation of explosives should be carefully inspected at the beginning of the day's work to ensure that:

- The vehicle is in good condition in all respects for safe transportation of explosives.
- The chassis, engine and body are clean and free from surplus oil and grease.
- The fuel system of the vehicle, including the fuel tank(s) is free from leakage.
- All electrical wiring and equipment are in sound condition.
- Lights, brakes and steering mechanism are in good working order.
- The fire extinguishers are serviceable and in position on the vehicle.
- The driver is trained in the use of extinguishers on his vehicle.
- The exterior of the body of vehicle is to be painted with the word 'EXPLOSIVES' not less than 100 mm high letters in white over a red background in English and local language on both sides and ends.
- Two carbon dioxide fire extinguishers securely mounted and each of not less than 3 kg capacity (conforming to IS 2878:1986) is to be carried on each vehicles.

4.3.2 Precautions during transportation

Following safety precautions should be observed for transportation of explosives.

- The vehicles should be driven only by a licensed driver who is physically fit and is familiar with the precautions to be taken while carrying the explosives in his vehicles.
- All vehicles, preferably the body-work of each vehicle completely enclosed type with a properly fitting door and locking arrangement should be leak-proof.
- In open bodied vehicles, the floor should be leak-proof, the sides and ends should be of sufficient height to prevent the explosives from falling off the vehicle and the explosives should be covered with a waterproof and flame resistant tarpaulin.
- The chassis of the vehicles should be well sprung, the un-sprung country carts should not be used for the transportation of explosives.
- The vehicle carrying explosives should not be re-fueled except in emergencies and even then only when the motor has been stopped and other precautions have been taken to prevent accidents.
- No metals except metal truck bodies should be allowed to come in contact with cases of explosives. As far as possible, transportation of any other material (metal, flammable, or corrosive substances) along with explosives should be prohibited.
- Smoking should be prohibited in the vehicle carrying explosives and in its vicinity.
- No unauthorized person should be allowed in the vehicle carrying explosives.
- Explosives and detonators of blasting caps should not be permitted to be transported in the same vehicle.
- Care should be taken in loading and unloading of explosives. The filled containers should not be handled roughly or dropped.
- Drivers should not leave the vehicles unattended while transporting explosives.
- The speed of the vehicle should not exceed 25 km/h on rough roads and 40 km/h elsewhere.

- Vehicles carrying explosives should not be taken into a garage, repair shop or parked in congested areas, public parking or similar places.
- Explosives should not be transported in trailers. Further, any trailer should not be attached to a motor truck or vehicle when it is being used in transporting explosives.
- Explosives should not be transported on public highways during darkness, except in emergencies and even then only when the written approval of the project authorities has been obtained. Such vehicles should be fitted with adequate warning lights on both ends, while operating in darkness.
- Explosives should not be transferred from one vehicle to another on public highways, except in cases of emergency.

4.5 Weight of Consignments

The quantity of explosives that may be transported by different modes of transport shall be as given as under.

- For transportation by rail, unless otherwise permitted, quantity of explosive in any wagon shall not exceed 4500 kg. The minimum gross wagon load (inclusive of weight of packing cases) shall be 3000 kg, which is approximately equal to 102 cases of explosives if packed in wooden cases or 114 cases if packed in fiber board cases.

- For transportation by road, the quantity of explosive carried in any single vehicle shall not exceed 75 percent of the rated load carrying capacity of that vehicle or 3600 kg, whichever is less.

5. ब्लास्टिंग में उपयोगी सामग्री कर परीक्षण /Testing of material use for blasting

- All electric blasting caps shall be tested singly and also when connected in a circuit in series using only an approved type of circuit continuity tester or ohm meter.
- Each electric blasting cap should be tested with an approved Galvanometer before and after tamping in a hole to determine whether it will be carry the current.
- The circuit including of all caps should be tested with a circuit tester or Galvanometer before being connected to the firing line.
- Material used in blasting like explosives, cables, detonators, blasting cap etc. should be in accordance with the manufacturers catalogues and packed properly in a secured way.

6. ब्लास्टिंग की प्रक्रिया और तरीका /Procedure and method of blasting

Procedure of blasting has following steps:

i. Drilling
ii. Loading
iii. Electric shot firing circuit
iv. Blasting with safety fuse

Drilling:

- While planning drilling operations for blasting purposes, consideration must be given to the nature of stratums and the overburden with a view to avoiding the possibilities of land-slides after blasting.
- The face of rock shall be carefully examined before drilling, to determine the possible presence of unfired explosive.
- No attempt shall be made to drill at a site if undernoted explosives are suspected.
- The position of all holes to be drilled shall be marked out with white paint.
- The bore hole shall be carefully checked for length, presence of water, dust, etc, with a wooden tamping pole or a measuring tape before loading.
- Bore hole shall be cleared of all debris before explosives are inserted.
- The diameter of the bore of each hole shall be greater than the outside diameter of the cartridges of explosive.



- Loading and drilling shall not be carried out at the same time in the same area.
- Surplus explosives shall not be stacked near working areas during loading.
- The cap shall be inserted into a hole made with a pricker designed for the purpose.
- A hitch of the electric blasting cap leading wire shall be made on the primer cartridge so as to prevent pulling out of the electric blasting cap from the explosive charge.
- A bore hole near another hole loaded with explosives shall not be sprung.





Loading:

- In case of detonating fuse, the fuse shall be tied to the explosive cartridge so that the blasting cap is not pulled out.
- Care shall be taken so that the electric blasting cap, loading wire or the length of the safety fuse does not get damaged during loading of the charge.
- No attempt shall be made to slit, drop, deform or abuse the primer.

- No holes shall be loaded except those to be fired on the next round of blasting and after blasting, all remaining explosives and detonators shall be immediately returned to an authorized magazine.
- Blasting caps or electric blasting caps shall not be connected to detonating fuse except by methods recommended by the manufacturers of caps.
- No cartridge shall be cut or explosive removed from it for any purpose whatsoever.
- Metallic devices of any kind shall not be used in tamping.
- Wooden tamping tools with no exposed metal parts except non-sparking metal connectors for jointed poles shall be used.
- Violent tamping shall be avoided.
- Cartridges or explosives shall not be forced down a bore hole or on obstruction in a bore hole.
- Primer shall not be tamped.
- Care shall be taken to confine the explosives in the bore hole with sand, earth, clay or other suitable non-combustible stemming material.
- Kinking or injuring of fuse or electric blasting cap wires shall be avoided when tamping.
- No person shall be allowed to deepen drill boles which have contained explosives or blasting agents or insert a drill, pick or bore in butts of old holes even if examination fails to disclose explosives.
- Drilling shall not be resumed after blasts have been fired until a thorough examination has been made to make sure that there are no unexploded charges in the remaining butts of old holes or otherwise, which the drills may strike.
- Rock drillers shall be equipped with approved respirators for use in sillicious, dusty atmosphere arising out of drilling operations.
- In tunneling work, welding/cutting of metal shall not be done, inside the tunnel at the time of loading at the face, until the blast has been fired.

Blasting:

- Blasting shall be carried out only, with the permission of the engineer-in-charge.
- The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.
- The blaster shall be competent and qualified by reason of his training, knowledge or experience in the field of transporting, storing, handling, and using of explosives and having a working knowledge of Rules and Regulations pertaining to explosives.
- The blaster shall be in good physical condition and not be under influence of drugs, alcohol, intoxicants, etc.

Electrical Shot Firing Circuit:

- In deciding the sizes of wire, fuses, circuits, blasting switches, etc, instructions issued by the manufacturers of these articles shall be followed.
- No person shall attempt to uncoil the wires and open out the short circuited bare loading wires of the electric blasting cap during approach of dust storm or near any source of large charge of static electricity or near a radio transmitter.

- The manufacturer of the cap or the collector of explosives shall be consulted regarding the distance from the transmitter beyond which electric blasting shall be conducted.
- Firing circuit shall be kept completely insulated from the ground or other conductors, such as bare wires, rails, pipes or other paths of stray current.
- There shall not be any electric live wires or cables of any kind near electric blasting caps or other explosives except at the time and for the purpose of firing the blast.
- All electric blasting caps shall be tested singly and also when connected in a circuit in series using only an approved type of circuit continuity tester or ohm meter.
- No attempt shall be made to use in the same circuit either electrical blasting caps made by more than one manufacturer or electric blasting caps of different design or function even if made by the same manufacturers unless such use is approved by the manufacturers.
- No attempt shall be made to fire a circuit of electric blasting caps with less than the minimum current specified by the manufacturer of that electric blasting cap.
- Care shall be taken to ensure that all wire ends for electrical connections are bright and clean.
- The electric cap wires or loading wires shall be kept short circuited until ready to fire.
- When energy for blasting is taken from power circuits, the voltage shall not exceed 220 volt. The wiring and controlling arrangements shall conform to the following:

  a) The blasting switch shall be strictly according to the specifications, externally operated double-pole double throw switch, which when locked in the open position will short circuit and ground the leading wires. The switch shall be installed at the location where the firing is to be controlled;
  b) A ‘safety ’ switch of the same type as the blasting switch shall be installed between the blasting switch and the firing circuit and lead lines, at a distance not to exceed 180 cm from the blasting switch, and
  c) Both the safety switch and the blasting switch shall be locked in the open position immediately after firing the shot and before any person is permitted to the return to the blasting area. Key to the switches shall remain in the possession of the blaster at all time.

- Copper wires with solid cores of appropriate gauge shall be used for firing lines; the w res shall be adequately insulated and in sound condition.
- Blasting operations in the proximity of overhead power lines, communication lines, utility lines, or other structures shall not be carried out until the operator or the owner, or both of such lines have been notified and precautionary measures deemed necessary, have been taken.
- All holes loaded on a shift shall be fired on the same shift.
- As far as possible, blasting shall be carried out using suitable exploder with 2.5 percent excess capacity. Electric power from the mains shall be used only when it is absolutely necessary.
- Each electric blasting cap shall be tested with an approved galvanometer before and after tamping in a hole to determine whether it will carry the current.
- All testing shall be done by placing the galvanometer outside the tunnel and away from the tunnel face.

- The number of electric blasting caps used in a circuit shall not exceed the tested capacity of the blasting machine.
- The circuit, including all caps, shall be tested with a circuit tester or galvanometer before being connected to the firing line.

Blasting with safety fuse:

- The fuse shall be carefully handled to avoid damaging the covering. In very cold weather, the fuse shall be slightly warmed before using so as to avoid cracking the water-proofing.
- The minimum length of fuse shall be not less than that required by state laws in any case; it shall be not less than 750 mm.
- The maximum burning rate of the fuse shall be such that it will allow sufficient time to all concerned persons to reach a place of safety before the blast occurs.
- The burning rate of the fuse shall, in any case, be not more than 600 mm/min.
- Recommended minimum fuse lengths and maximum burning rates for normal conditions are given below:

Number of holes	Minimum fuse length in mm	Maximum burning rate mm/min
4-10	1800	450
11-12	2150	450

- The fuse shall not be cut until all preparations have been taken to insert it into a blasting cap.
- About 25 to 50 mm length of the fuse shall be cut from its end to ensure a dry end.
- It shall be cut squarely across with a clean and sharp blade.
- The fuse shall be seated lightly against the cap charge and care shall be taken to avoid twisting after it has been placed in position.
- Blasting caps shall not be crimped by any means other than a cap crimper designed for the purpose.
- It shall be necessary to make sure that the cap is squarely crimped to the face.
- The fuse shall be lighted with a fuse lighter designed for the purpose.
- If a match is used, the fuse shall be slit at the end and the match head held in the slit against the powder core and then the match head rubbed against an abrasive surface to light the fuse.
- The fuse shall not be lighted until sufficient stemming has been placed over the explosives to prevent sparks of live match head from coming into contact with an explosive.
- The explosives shall not be held in hands when lighting the fuse.
- Not more than 12 holes shall be loaded and shot at one time if cap and fuse are used for detonating.
- Only permissible explosives shall be used and that too in the manner specified by the appropriate authority. In case of ANFO is used, due care shall be exercised in doing more extensive temping so as to eliminate chances of static current being generated.
- Excessive quantities of explosives shall not be taken underground at any time.
- Black blasting powder or pallet powder shall not be used with any other explosives in same bore hole.

7. यातायात निरुद्ध और पावर ब्लॉक ओर ट्रैक एवं भवनों की सुरक्षा /Removal of traffic and/ or power block and Protection of tracks & buildings

a) In vicinity of railway line:

- Blasting operations within 100 meters of a running line should normally be carried out under block protection.
- Tracks within 60 meters of the rock to be blasted should be protected by covering with old sleepers which should be removed after the blasting is over and before removal of the block.
- When the blasting operation is carried out without imposition of the block, the Permanent Way Inspector shall ensure protection to trains in such a case, no blasting should be done within half-an-hour of the time when any train is expected to pass.

b) In vicinity of buildings:

- When any blasting operation is carried out within 100 meters of a building, the Works Inspector shall be present to ensure that special precautions, as may be prescribed by the Divisional/ Dy. Chief Engineer or the Assistant Engineer or as stipulated by the licensing authority, are taken and that the necessary warning is given to the inhabitants.

8. ब्लास्टिंग के पहले ब्लास्टिंग के दौरान एवं बाद की सावधानियाँ /Precaution before, during and after blasting

- Before blasting, sufficient warning shall be given to enable the people working in the blasting area to get off the danger zone.
- All persons, other than blaster, shall leave the danger area at least 10 minutes before the blasting starts.
- The danger zone shall be suitably cordoned off and flag men posted at important points.
- No loose materials, such as tools, drilling implements, etc, shall be left on the rock surfaces to be blasted.
- Blasting in the open shall be carried out during fixed hours every day or on fixed days in the week. This information shall be amply publicized and the following precautions observed:
  a) All approaches to the project site, where regular blasting operations are undertaken, shall be sign-posted for warning the public and indicating the days and timings when blasting is to be carried out.
  b) All approaches to the project site, shall be closed by barriers at a distance of not less than 400 m, 10 minutes before firing is to take place, and
  c) Loud wailing note of not less than 1 minute duration shall be sounded on sirens to warn the public before commencement of firing.
  d) The end of firing operations must be followed by sounding an all clear signal on the sirens as a continuous long note of not less than 1 minute duration.
- Each bore hole shall be thoroughly cleaned before a cartridge is inserted.
- Wooden tamping rods (not pointed, but cylindrical throughout) shall be used in charging the holes.
- The cartridges shall be gently placed and not rammed.

- The primer cartridge shall be on the top.
- The blaster shall not return to blasting site after firing, until at least 5 minutes have elapsed.
- In case of electric shot firing, the shot holes shall be examined after blasting and in case of misfire no person shall be allowed to approach the blasting site for at least 5 minutes.
- In case of blasting with safety fuse, utmost care shall be taken to count the number of loud reports to ensure that all the shots have fired and in the event of misfire, no person shall be allowed to approach the blasting site for at least 30 minutes.
- In any case all holes shall be carefully inspected for residual undetonated explosives after firing the shots.
- No other person than those duly authorized shall approach the holes until one of the following operations has been performed in respect of each of the misfired holes:

  a) If the misfire is due to a faulty cable or faulty electrical connection the defect shall be remedied and the shot fired;
  b) The stemming shall be floated out by use of water or air jet from hose until the hole has been opened to within 60 cm of the charge, whereupon water shall be siphoned or pumped out, then a fresh new charge placed and duly detonated; and
  c) A new hole shall be drilled 60 cm away from the old bore and parallel to it and about 30 cm less in depth and the new hole charged and duly fired.

- If a shift change is unavoidable, the person in charge of the outgoing shift shall, before leaving the work, inform the person relieving him of any cases of misfired shots, point out to him their positions, duly cross-marked, and also state clearly what action remains to be taken in each case.
- After blasting it must be ensured to check for any loose/ hanging materials & these should be fallen down positively and nothing should be left loose or precariously hanging.

09. आवृति प्रोग्रैस रिपोर्ट जमा करना /Submission of periodical progress report

- Account should be maintained carefully day to day in an approved register and manner by the competent authority, which should be open to inspection at all times by the concerned departments or authorities.
- Explosives shall be issued only to competent persons upon written requisition signed by the blaster or by an official authorized for the purpose and only against the signature or thumb impression. Such requisitions shall be preserved by the person in charge of the magazine.

10. मैगज़ीन के विस्फोटकों की सुरक्षा एवं रखने का लेखा-जोखा / Custody and storage of explosives in magazine and their account

- Storage of explosives is regulated by the Indian Explosives Act and provision there under should be strictly observed.
- Explosives shall be stored only in a magazine which is clean, dry, well ventilated, reasonably cool, correctly located, protected against lightning in accordance with Indian

Electricity Act and Indian Explosives Act and rules and regulations framed there under substantially constructed bullet and fire resistant and securely locked.

- The storage should be done in such a way that the first stored should be used first and to have this facility, the explosives should be stored in sequence.
- Blasting caps, electric blasting caps or primers shall not be stored in the same box, container or room with other explosives.
- Explosives fuse or fuse lighters shall not be stored in a damp or wet place or near oil, gasoline, cleaning solutions or solvents or near radiators, steam pipes, or other sources of heat.
- Smoking and use of matches, naked lights and readily flammable articles or open fires/flame shall be prohibited within the fenced area around it. Suitable notices to this effect shall be conspicuously posted at appropriate locations.
- An area up to a distance of not less than 8 m on all sides of the magazine shall be maintained free of all vegetation, debris and combustibles. Oily cotton rags/waste and articles liable to spontaneous ignition shall not be allowed in or near the magazine.
- Metals, metallic objects and metal tools that are capable of producing sparks shall not be stored or used inside or in the immediate vicinity of the magazine.
- If nitroglycerine from deteriorated explosives has leaked down onto the floor of the explosive magazine, the floor shall be desensitized by washing thoroughly with an agent obtained before hand from the supplier of the explosives. For this purpose, desensitizing agents and the instructions for using them shall always be obtained along with the supply of nitroglycerine.
- Magazine shoes, without nails, shall be kept at all times in the magazine, and a wooden tub or cement trough, approximately 300 mm high and 450 mm in diameter, filled with water shall be fixed near the door of the magazine. Persons entering the magazine shall put on the magazine shoes provided for the purpose, and be careful not be allow the magazine shoes to touch the ground outside clear floor. Persons with bare feet shall, before entering the magazine, dip their feet in water, and then step direct from the tub over the barrier (if there is one) on to the clear floor.
- A brush or broom shall be kept in the lobby of the magazine for cleaning the magazine on each occasion it is opened for the receipt, delivery of inspection of explosives.
- Boxes of explosives shall not be thrown down or dragged along the floor and may be stacked on wooden trestles. Where there are white ants, the legs of the trestles should rest in shallow copper, lead or brass bowls, containing water.
- Packages containing explosives shall not be allowed to remain in the suh.
- Empty boxes or packing materials shall not be stored or permitted to be around, inside or in the vicinity of the magazine.
- Adequate quantity of water and fire-fighting equipment shall be provided in the magazine. Guards shall be properly trained m handling such equipment.
- Signboards reading “DANGER-HIGH EXPLOSIVES” “PROTECTED AREA” “NO SMOKING”, etc, shall be prominently displayed in front of the magazine.
- Well trained armed guard shall be posted to guard the magazine.
- The following shall be hung up in the lobby of the magazine:
  a) A copy of Explosives rules,
  b) A statement showing the stock in the magazine, and
  c) Certificate showing the last date of testing of the lightning conductor.

- For continued blasting-operations, the magazine shall be located at a safe distance near the work-site and actual requirements of explosives for each blast may be drawn and transported to the site; left over, if any, must be immediately returned to the magazine. Where the blasting operations extend to several scattered sites and/or one of a short duration, portable magazines shall be used. Each such magazine shall be located at a safe distance from the work site, enclosed in a fence and properly guarded.

11. विस्फोटकों का निपटारा /Explosive disposal

- No explosive shall be abandoned. These shall be disposed off or destroyed strictly in accordance with the approved methods and in doing so the manufacturers or the appropriate authority shall be consulted.
- Explosives, caps, boxes liners or material used in packing of explosives shall not be left lying around in places to which children or unauthorized persons or livestock can have access.
- Paper or fibrous material employed in packing explosives shall not be put to any
- Subsequent use. Such material shall be destroyed by burning in the presence of a responsible person.

12. विस्फोटकों का निरस्तीकरण /Destruction of explosives

The destruction of explosives should, in all cases, be supervised by the Assistant Engineer. When destroying explosives, the following instructions should be strictly adhered to:-

a) **Black powder**- Black powder should be thrown into water, preferably hot water, which dissolves out the saltpeter and renders the explosive harmless. An alternative method is to lay it out in a train and fire this from one end by means of a piece of safety fuse, but if more than one train is laid, care should be taken to lay the second at such a distance from the other as to run no risk of one being fired by the heated ground of another.

b) **Dynamite and other similar explosives –**

- Not more than 2.5 Kg. of the explosive should be destroyed at a time.
- A clear space of ground, free from dry grass, about 100 square meters should be selected at least 800 meters away from buildings and dwelling places.
- A line of shavings or dry grass, about 450 mm wide and at least 100 mm thick, should then be laid down.
- The direction of the line should be at an angle of about 45 degrees to the direction of the wind.
- The work should not be undertaken on a day when the wind would be strong enough to disturb or blow away the shavings.
- This line of shavings or dry grass should then be adequately sprinkled with kerosene oil to ensure its burning continuously.

- The cartridges with the wrappers opened and unrolled should then be placed in a continuous line not more than 2 abreast with an interval of 25 mm between each line of cartridges and with the cartridge wrappers or other paper lightly placed below them.
- The cartridges should be placed at about 6 meters from the weather end of the line of shavings, at the extreme weather end of which will be placed an adequate length of safety fuse.
- To ensure the ignition of the shavings, it may be found necessary to place a small quantity of cotton waste soaked in petrol adjacent to the end of the safety fuse and on the shavings.
- The safety fuse should then be lighted and the operator should retire quickly to a safe distance when after a short time the dynamite will burn steadily without exploding.

c) **Detonators -**Surplus detonators should be disposed of by throwing them, one at a time, into a deep pool of a river or the sea. An alternative method is to soak them thoroughly in light mineral oil for 48 hours and then destroy them by throwing them one at a time into a fire with due precautions.

d) Safety fuse - Safety fuse should be destroyed by burning in lengths in the open.

चेकलिस्ट /Check List

S.N.	Particulars	Y	N
	It shall be ensured that:-		
	For Blasting Mate		
1.	Weather the permission of engineer in Charge is accorded before blasting.		
2.	Weather the blaster is physically fit and not influence with drugs and alcohol		
3.	Blasting Mate is having valid license. (Copy of licence should be available at site)		
4.	Blasting Mate is having valid registration. (Copy of registration should be available at site)		
5.	Watchmen are deputed to stop the traffic or to warn the people		
6.	There is proper communication arrangement between watchmen and work spot.		
7.	There is the arrangement of siron for warning before and after blasting.		
8.	Area is protected by barricading		
9.	Proper warning boards are displayed		
10.	It is ensured that there is no person other than blaster is inside the protected area.		
11.	It is ensured that shallow bore holes are drilled to avoid damage in structure in close proximity to the blasting area		
12.	It is ensured that light charge are used for blasting to avoid damage in structure in close proximity to the blasting area		
13.	Select suitable person as carrier of explosives		
14.	Suitable instructions are given to person select as carrier of explosives.		
15.	Basting area is smoke free within 10 m of operator or handling of explosives.		
16.	The sizes of bore holes are as per requisite diameter.		
17.	The depths of bore holes are as per requisite depth.		
18.	Bore holes are checked for clear from all debris before insertion of cartridges.		
19.	The key of exploder kept by blasting Mate only.		
20.	The Blasting Mate have copy of rules framed by central, state and local bodies and they are being complied.		
21.	Weather the supervision of loading/ unloading/handling is done by qualified person.		
22.	Weather that person is checked for knowledge about the rules framed.		
	Magazine		
23.	Proper account of explosives is maintained.		
24.	It is ensured that the explosives are stored in sequence.		
25.	Magazine is accordance with Indian Explosive act.		
26.	It is ensured that the blasting cap, electrical blasting cap or primers should not be stored in the same box, container or room with other explosives.		
27.	It is ensured that the area surrounding the magazine not less than 08 metre is free of all vegetation, debris, and combustibles.		
28.	It is ensured that the empty boxes or packing materials should not be stored in magazine or in vicinity of magazine.		

29.	Proper sign boards like "DANGER- HIGH EXPLOSIVES", "PROTECTED AREA", "NO SMOKING" are displayed on magazine.		
30.	Well trained armed guard is posted to guard the magazine.		
31.	It is ensured that adequate quantity of water and fire fighting equipments are provided in the magazine.		
32.	In the lobby of magazine following are hung up; a) Copy of explosive rules b) Stock statement of magazine c) Certificate showing the last date of testing of the lighting conductor.		
	Loading and unloading		
33.	It is ensured that all switches are off, when loading/unloading of explosives.		
34.	The explosives are carried in specially designed containers.		
	Transportation		
35.	The vehicle driven by the valid license holder.(Copy of licence should be available with driver)		
36.	The condition of vehicle contains explosives is good.		
37.	Body of vehicle is leak proof.		
38.	Vehicle having proper door and locking arrangement.		
	Protection of track and buildings		
39.	Block is taken when blasting operation is within 100 m of track.		
40.	Track is properly protected when blasting is within 60 m of track.		
41.	It is ensured that the no blasting should be done within half an hour of the time when any train is expected to pass.		
42.	Necessary warning is given to the inhabitants		
	Blasting		
43.	Use of short piece of fuse is prohibited.		
44.	Any power line in proximity of blasting area.		
45.	If power line is there, precautionary measure is adopted.		
46.	Electrical blasting cap is tested by approved galvanometer.		
47.	It is ensured that the minimum length of fuse is 750 mm		
48.	The blasting cap is crimped with designed cap crimper.		
49.	Vehicle is marked following		
	a) Name of manufacturer		
	b) Trade name		
	c) Name of explosives		
	d) Lot no.		
	e) Date of manufacture		
	f) Expiry date		
50.	The exterior of the vehicle marked EXPLOSIVE at both side		
51.	CO_2 based fire extinguisher are mounted at vehicle		
52.	Capacity of fire extinguisher are in accordance with IS2878:1986		

ADEN **SSE/JE** **Blasting Mate**

संदर्भ / REFERANCE

1	IS: 4081-1986 Indian Standard Safety Code for Blasting and Related Drilling Operations.
2	IS: 4756-1978 Indian Standard Safety Code for Tunnelling Work.
3	Indian Explosive Act
4	Metalliferous Mines Regulations
5	Indian Railway Work Manual
6	Miscellaneous references from various web sites and text books

***

टिप्पणी / NOTES

गुणवत्ता नीति

रेलों में यात्री और माल यातायात की बढ़ती माँग को पूरा करने के लिए गुणवत्ता प्रबंध प्रणाली में अनुसंधान, डिज़ाइनों और मानकों में उत्कृष्टता तथा सतत सुधारों के माध्यम से सांविधिक और नियामक अपेक्षाओं को पूरा करते हुए सुरक्षित, आधुनिक और किफ़ायती रेल प्रौद्योगिकी का विकास करना।

QUALITY POLICY

To develop safe, modern and cost effective Railway technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs & Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the Railways.

डिस्क्लेमर / Disclaimer

The document prepared by CAMTECH is meant for the dissemination of the knowledge/ information mentioned herein to the field staff of Indian Railways. The contents of this handbook/booklet are only for guidance. Most of the data & information contained herein in the form of numerical values are indicative and based on codes and tests/trials conducted by various agencies generally believed to be reliable. While reasonable care and effort has been taken to ensure that information given is at the time believed to be fare and correct and opinion based thereupon are reasonable. Due to very nature of research it can not be represented that it is accurate or complete and it should not be relied upon as such. The reader/user is supposed to refer the relevant codes/ manuals available on the subject before actual implementation in the field.

हमारा उद्देश्य

अनुरक्षण प्रौधौगिकी और कार्यप्रणाली को उन्न्यन करना तथा उत्पादकता और रेलवे की परिसम्पत्तियों एवं जनशक्ति के निष्पादन में सुधार करना जिससे अंतर्विषयों में विश्वसनीयता, उपयोगिता और दक्षता प्राप्त की जा सके।

यदि आप इस संदर्भ में कोई विचार और सुझाव देना चाहतें हों तो इस पते सम्पर्क करें।

सम्पर्क सूत्र	:	**संयुक्त निदेशक (सिविल)**
टेलीफोन	:	0751–2470869
फैक्स	:	0751–2470841
ई-मेल	:	**dircivilcamtech@gmail.com**

Our Objective

To upgrade Maintenance Technologies and Methodologies and achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability, and Utilisation.

If you have any suggestion & comments, please contact to us:

Contact person	**:**	**Joint Director (Civil),**
Phone	**:**	**0751 - 2470869**
Fax	**:**	**0751 – 2470841**
Email	**:**	**dircivilcamtech@gmail.com**